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PRELIMINARY CROWN WEIGHT ESTIMATES FOR TANOAK, BLACK OAK, AND PACIFIC MADRONE

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Abstract

Preliminary tables for estimating dry weights of whole trees and of crown components are presented for California black oak and tanoak; total tree weight only for Pacific madrone. Crown component weights were generated from data of two earlier studies, one from the Appalachians and one from the Pacific Northwest.

KEYWORDS: Biomass, weight tables, crown weights, hardwoods, tanoak, *Lithocarpus densiflorus*, California black oak, *Quercus kelloggii*, Pacific madrone, *Arbutus menziesii*.

INTRODUCTION

To help land managers assess hardwood biomass, for either fire hazard appraisal or fiber utilization potential, this Research Note presents preliminary whole tree weights for three species--tanoak (*Lithocarpus densiflorus* (Hook. & Arn.) Rehd.), California black oak (*Quercus kelloggii* Newb.), and Pacific madrone (*Arbutus menziesii* Pursh.). For tanoak and California black oak, preliminary weights for tree components are also given.

DISCUSSION AND RESULTS

To construct the weight tables, I used two studies--one from the Pacific Northwest (Sundahl 1966) and an unpublished one from the Appalachians by Loomis.[1] Sundahl collected total tree weight data for three hardwood species in Yuba County, California.[2] The species

[1] R. M. Loomis. Unpublished data, on file at North Central Forest Experiment Station, East Lansing, Mich.

[2] Total tree weight includes bole (bark and wood), branches, and foliage.

sampled and their associated sample sizes were: 8 tanoak (0.8- to 19.8-inch d.b.h.), 7 California black oak (0.6- to 22.0-inch d.b.h.), and 10 Pacific madrone (0.4- to 22.1-inch d.b.h.).[3]

Regression equations for total tree weight were made for each species. The regression model used is:

$$\ln W = \ln a + b\,(\ln d);$$

where:

W = total tree weight (lb) by species.[4] Total weight includes foliage, all branchwood, unmerchantable tip, and bole.
d = diameter at breast height (inches),
a and b = regression coefficients,
ln = natural (Naperian) logarithm.

Regressions for each species showed high correlations, with coefficients of determination of 0.99. The regression line fit the data points so closely that any logarithmic bias would have been negligible. Therefore, the mean square error divided by 2 was not added to the "a" coefficient to correct for bias caused by logarithmic transformations (Baskerville 1972).

Sundahl (1966) collected total tree weight, separated out crown weight, but did not separate the crown into component size classes,[5] nor has any other west coast hardwood study examined crown component size classes with their respective weights. Therefore, a study on hardwoods from the Appalachians was used. Loomis (see footnote 1) had collected data on red oak (*Quercus rubra* L.) from the Appalachians and had separated the crown components. His data are unpublished but supply preliminary equations for weight of foliage and branchwood, as well as proportion functions to separate branchwood weight into component size classes.

Before I put together the results of the Pacific Northwest and Appalachian studies for preliminary weight estimates of west coast hardwood components, I made two assumptions:

1. Tanoak and California black oak (two Pacific Northwest species) have the same crown component size-class weights as red oak (an Appalachian species). Since there has been no study on Pacific Northwest hardwoods that examined crown weight by size-class components, this assumption was necessary to construct the weight tables.

2. Tanoak and California black oak total tree weights for a given d.b.h. are approximately the same. A graph of their respective functions indicated this was true.

With the above assumptions, I estimated weights for crown components of tanoak and California black oak combined (table 1). I used equations developed for the foliage and branchwood weight of the Appalachian species, red oak. I further separated the estimated branchwood weight into component size classes by using proportion functions also developed from red oak. The proportion functions could not be used with Sundahl's (1966) crown weights because of differences in crown definitions. Sundahl (1966) measured branchwood to 4-inch diameter, and the study on red oak measured branchwood up to where the branches joined the bole. The total crown weight, once calculated, was subtracted from Sundahl's (1966) total tree weight for an estimate of bolewood weight. The weight shown under "Bole" (table 1) includes weight for unmerchantable tip, dead branchwood, and bolewood.

The net effect of the above functional manipulation would possibly bias the crown component size-class weights. The total tree weight, however, is an unbiased estimate made from a limited source of data collected in Yuba County, California. Any bias in the crown component weights should be consistent, and the user should be able to recognize this by making periodic postactivity down-woody inventories (Brown 1974).

Assumptions similar to those outlined earlier for California black oak, tanoak, and red oak could not be made for Pacific madrone. Therefore, only the total weights of trees were estimated and

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[3] To change inches to centimeters, multiply by 2.54.

[4] After solving the equation, to change pounds to kilograms, multiply by 0.454.

[5] Component size classes: Foliage, 0- to 0.24-, 0.25- to 0.99-, 1.0- to 2.99-, and 3.0+-inch diameter (outside bark) branchwood.

Table 1--Preliminary component weights of tanoak and California black oak[1/]

D.b.h.	Foliage	Branchwood diameter[2/]				Crown	Bole[3/]	Total tree
		0-0.24 inch	0.25-0.99 inch	1-2.99 inches	3+ inches			
Inches	Pounds[4/]							
1	0.5	0.2	0.1	0	0	0.8	2.2	3.0
2	1.3	.6	1.5	0	0	3.4	10.5	13.9
3	2.4	1.2	4.4	.4	0	8.4	25.7	34.1
4	3.7	1.8	6.9	4.2	0	16.5	48.1	64.6
5	5.1	2.6	9.7	10.9	0	28.3	77.7	106.0
6	6.8	3.4	12.8	21.3	0	44.2	114.7	158.9
7	8.5	4.3	16.2	35.7	0	64.7	159.0	223.8
8	10.4	5.3	19.8	54.8	0	90.4	210.6	301
9	12.4	6.4	23.7	73.2	5.8	121.5	269.5	391
10	15	8	28	87	21	159	335	494
11	17	9	32	102	42	202	409	610
12	19	10	37	118	68	252	489	741
13	22	11	42	135	100	309	576	885
14	24	13	47	152	138	374	669	1,043
15	27	14	52	171	182	446	770	1,216
16	30	16	57	190	234	526	876	1,403
17	32	17	63	210	293	615	990	1,605
18	35	19	69	231	359	713	1,109	1,822
19	38	20	74	253	434	820	1,235	2,055
20	41	22	80	275	517	936	1,367	2,303
21	44	24	87	299	608	1,062	1,504	2,566
22	48	26	93	322	709	1,198	1,648	2,846
23	51	27	100	347	819	1,344	1,797	3,141
24	54	29	106	372	939	1,501	1,951	3,452
25	58	31	113	399	1,068	1,669	2,111	3,780

[1/] To change pounds to kilograms, multiply by 0.454. To change inches to centimeters, multiply by 2.54.

[2/] The branchwood was measured to the main bole.

[3/] The bole weight includes the unmerchantable tip, dead branchwood, and bolewood.

[4/] Ovendry weight.

summarized in table 2. For an indication of Pacific madrone's total crown weight, Sundahl's (1966) tanoak and California black oak crown weights were averaged for large trees (12- to 22-inch d.b.h.) and subjectively compared with weights for Pacific madrone. The comparison indicated that Pacific madrone's crown weight was approximately 30 to 50 percent lighter than the average of tanoak and California black oak; however, a comparison of total tree weights from tables 1 and 2 indicated madrone's total weight is noticeably heavier.

Statistical analyses were not possible because of lack of compatible data and sampling designs between researchers. It was my intent to give practitioners who work in areas with substantial amounts of west coast hardwoods the capability of making reasonable biomass weight estimates. Because the values given in tables 1 and 2 are based on a limited number of trees, they should be used with caution.

To use the tables, estimate the number of trees per acre by species and d.b.h. and multiply by the corresponding coordinate value in the table. The product of the weight per tree from the table and trees per acre will give an estimate of weight per acre for any given d.b.h. class. Estimates should be made only on a per-acre basis, not for individual trees. This should help prevent gross bias in weight estimates.

Table 2--Preliminary total tree weights for Pacific madrone[1/]

D.b.h.	Total tree weight	D.b.h.	Total tree weight
Inches	Pounds[2/]	Inches	Pounds[2/]
1	2.6	13	1,031
2	13.2	14	1,225
3	34	15	1,438
4	66	16	1,672
5	112	17	1,925
6	171	18	2,199
7	244	19	2,494
8	333	20	2,810
9	438	21	3,148
10	560	22	3,508
11	699	23	3,890
12	856	24	4,295

[1/] Total tree weight includes: bole (wood and bark), foliage, unmerchantable tip, and all branchwood. To change pounds to kilograms, multiply by 0.454; to change inches to centimeters, multiply by 2.54.

[2/] Ovendry weight.

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